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The Influence of Personal, Social, and System
Factors on Team Problem Solving

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Stanford University

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Social Psychology Laboratory

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Intervention in the communication process during team problem-solving activities was achieved by use of: computer-mediated turn-taking algorithms, computer displays of feedback (informational prompts) regarding each member's on-going amount of participation, and assignment of leadership roles. Outcome measures included quality of team decisions, extent of individual verbal participation, social-emotional reactions, and group dynamics.

This exploratory research reveals the promise of an experimental approach to studying computer-mediated message systems in problem-focused work teams. But it is also evident that therapeutic or remedial interventions designed to improve team effectiveness must take account of the complex interactions among variables operating at dispositional, social, ecological, and system levels.

Abstract

This final report summarizes five experiments conducted to find ways of improving the process and outcome of team problem solving. Our basic approach has tested strategies for increasing the extent of involvement among individuals whose level of participation is typically low.

A computer-controlled message system was developed and utilized to investigate communication processes in four-person problem-solving teams. Several variables that bias the extent of an individual's verbal participation on group tasks were identified. Equitable (or democratic) participation in task-centered work teams is affected by dispositional factors, such as communication apprehension or shyness, by social-situational factors, such as gender (sexual) composition of teams, and by leadership roles.

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Overview of Research Program

The primary goal of this three-year program of research has been to discover variables that can be manipulated to improve the performance of problem-solving teams. Modification of small-team effectiveness depends on the interaction of many factors that together influence team processes and outcomes. Some factors relate to specific job skills, human-engineering concerns of equipment design, and the ecology of member/team/machine/communication modality. However, these factors lie beyond the province of our research focus and expertise. Our concern has centered instead on several of the dispositional and situational variables that contribute to the social psychological nature of a team's composition and its operational dynamics.

Our analysis has been guided by the assumption that optimal team performance usually requires sharing of available resources among members. Sharing information-based knowledge and social-emotional support are vital to small group effectiveness. For many types of team tasks, markedly unequal levels of team member participation should generate an adverse effect upon the quality of the primary task outcome--the solution to the team's problem. When some members of the team withhold potential contributions, the team cannot fully benefit from their wisdom and skills. In addition, when participation rates differ to an obvious extent, the "social climate" of the team suffers as well. Those not contributing fully are likely to become more bored and to feel less competent. Their self-esteem will be lowered, while their dependence upon those to whom they defer is increased. The high contributors, on the other hand, should

enjoy their superior status. Over time, though, they may come to resent the inequity of a situation that forces them to carry a heavier burden of responsibility for the team's success. Thus, the reactions of both low and high contributors combine to lower group morale and reduce feelings of group cohesiveness.

When a team needs to work together over an extended time period, such reactions will threaten its stability. Attempts may be made to reorganize the team. If more balanced participation is achieved, it should be accompanied by enhanced attitudes toward the group process, its products, and its unique identity. With fuller participation and more positive team attitudes, the probability of attaining the team's goals--of effective problem solving--should be increased. However, if the imbalance continues, team members may 'defect' to more personally rewarding teams or, if possible, leave the field. In military and institutional settings this should be reflected in greater turn-over and lower rates of re-enlistment.

We must, of course, acknowledge that autocratic groups (in which one or a few competent members dominate) may be quite effective for many tasks. However, across many problem domains and over time, they should suffer in comparison to groups characterized by more democratic participation. The disadvantage should be revealed not only on social-emotional "climate" variables, but also on task variables when the dominant leaders do not possess all the necessary resources, are forced to function under high levels of stress, or must make judgments in the absence of complete information. If democratic team functioning is a desired institutional goal, then system variables interfering with that

objective need to be identified and modification strategies instituted. Our research, conducted under this O.N.R. contract, established a methodology for both isolating some of these variables and developing therapeutic tactics for systematically altering levels of verbal participation in work groups.

At a social-structural level of analysis, participation is affected by: power relationships (based on authority, expertise, intelligence, seniority); status hierarchies (based on role, authority, rank, socio-economic class, race, sex, and age); degree of structure or freedom in the group; communication network patterns, and implicit norms governing communication.

At the individual level of analysis, unequal rates of participation may be due to: interpersonal communication deficiencies (lack of practice or experience, and lack of requisite verbal skills), and/or personal psychological problems (chronic reticence or shyness, low self-esteem, and anticipated critical feedback).

We have found in the context of the present research (as well as in our other O.N.R.-supported research on shyness, Brodt & Zimbardo, 1979; Zimbardo, 1977), that a substantial proportion of the population has developed a response style involving minimal participation in group activities. Some have a reinforcement history in which their ideas and contributions were not regularly acknowledged, accepted, or rewarded by their groups. Others have learned to defer to authority, to expect dominant group members to initiate, while they either follow or react to plans proposed by these teammates. Such individuals may make immediate social comparisons within their group, typically judge themselves to be less adequate in requisite skills, and then, as a consequence, adopt a

secondary status. Among those with chronic low self-esteem, potential contributions will be self-denigrated before they are ever expressed publicly—and then held back.

Those who have come to be apprehensive about interpersonal communication obviously put themselves at a disadvantage when placed in any team structure where communication is vital to coordinating individual efforts, making group decisions, and sharing skills, resources and social support. In addition to these chronically reticent or shy individuals, there are other classes of individuals whose public responding is inhibited or constrained only in particular group settings. Minority group members often display such behavioral suppression when functioning within a team composed primarily of those from the majority group. Women, and those from racial and ethnic minority groups, often alter their expectations and behavior when placed in job settings that are largely male, white, and anglo-saxon. They may not perform up to the true level of their ability, not contribute the fullest extent of their wisdom and expertise, and not be motivated to learn appropriate team roles necessary for the most effective, interactive team functioning.

It must be noted however, that unbalanced team participation is not solely attributable to self-concept problems and learned habits of low responding among the shy, women, and minority group members. Our conceptual analysis also focused on the learned dominance and expectations for control of those who participate with high frequency. They act in a variety of ways to establish a "verbal power domain" over team members who are more reticent or deferential. They have developed learned styles of taking charge of group interactions. They do so by: initiating the conversation, talking more often and for longer, interrupting others, and

not allowing themselves to be interrupted. By controlling the quality of verbal inputs, they often affect the quality of group discussions as well. They tend to determine the topic(s) for discussion, propose options, suggest strategies, and establish goals, while they also monopolize and govern the operation of turn-taking.

This vocal minority, all too often, assumes the decision-making responsibilities for the whole group. Their learned history of being reinforced for adopting the extroverted, task-directing leadership role enables them to do so even when in a new team situation. At the same time, they act as a dominant force to suppress the initiative and risk taking of the reticent members of their team. They help cast these individuals into their role by reinforcing them only for serving as passive, acquiescing listeners.

Many situations arise in everyday civilian and military life that call for the concerted efforts of individuals in formulating group solutions to their common problems. However, as we come to rely more on increasingly sophisticated technology, the reliance of the group on the expert looms larger. And so does the prospect of unbalanced participation in group decision-making. Similarly, as women and minority group members play a more important role than previously in the work force and in the "new Navy," the issue of undemocratic group participation becomes more than a problem of values. Integration of their contributions within the functioning of their work teams becomes a matter of operational necessity.

New ways need to be explored that will enable the technically proficient to share their knowledge with other team members rather than use it as a source of power over them. In like manner, new training procedures and organizational structures are called for to increase the

extent of participation in team problem-solving efforts by those who are habitually reticent, notably the dispositionally shy, women, and minority group members. In the military situation, the anticipated more favorable reaction to balanced participation in teams is expected to generalize to larger operational units (of which the small team is the basic component). If so, then one positive "side effect" should be seen in increased commitments to the Navy, and thus more reenlistments.

The present program of research has attempted to develop a technology and research paradigm for modifying levels of verbal participation within problem-solving teams. We have studied differences between shy and not-shy team members as well as male-female differences in verbal participation. After describing our basic research paradigm, we will outline the variables investigated in each of our five experiments along with the major findings. Fuller details of procedures, results, and interpretation are found in Zimbardo, Linsenmeier, Kabat, and Smith (1982) and Linsenmeier and Zimbardo (1982).

Research paradigm: Computer mediation

One of the most powerful, yet subtle, mediators of verbal interaction within a group is group norms governing turn-taking. Who talks when, for how long, and how often depends upon implicitly acknowledged rules. These rules govern access to the attention of the group as a whole by those with greater authority and status. But even when participants begin an interaction unaware of a priori power differences, system rules often emerge as a consequence of individual differences in assertiveness-reticence and dominance-deference.

Among the emergent system rules (or algorithms) that influence the extent and quality of interaction are:

- (a) autocratic rules that give priority to those who request to talk first and thus initially control the domain of the interaction; these individuals seek opportunities to participate more actively and quickly than their teammates, and do, in fact, obtain the floor more often (FIFO - First In - First Out);
- (b) democratic rules that attempt to equalize speaker opportunities over the entire course of the interaction (EQTS - Equal Time Sharing);
- (c) quasi-democratic rules that give everyone an equal chance to participate the first time around, but then give priority to those who are most verbally fluent, assertive, or involved.
- (d) altruistic rules that recognize the disproportional rates of participation and handicap those who are initially high participators, thereby establishing that the last-shall-be-heard-too.

Over the past three years we have designed, developed, and tested a message-handling system that can interpose algorithms into a group discussion in order to determine speaker selection by means of computer mediation. Different turn-taking rules (FIFO and EQTS) have been programmed into the computer to mediate requests to talk. Our first study utilized a computer-mediated message transmission system developed by David Stodolsky (1976). Subsequent studies (after Stodolsky left the project) used a program written by Peter Smith (for use with the PDP 11/34 laboratory computer).

Our primary experimental situation is characterized by the following features:

- (a) Four individuals, previously unknown to each other, are assembled as a problem-solving team.
- (b) They are physically separated and can communicate orally by means of an intercom system and in writing by typing responses on computer terminals (selected responses are shown on the CRT display screens of other subjects).
- (c) To request the opportunity to talk, a team member presses a talk-request button and keeps it activated until displayed instructions announce that he or she has the floor (e.g., "subject X, you may talk now").
- (d) The subject who is granted the opportunity to talk by the computerized telecommunication system then presses a talk button that activates a microphone, allowing the other team members to hear what he or she says through their earphones.
- (e) Subjects are told how long each discussion period will be, allowed one minute maximum of uninterrupted talk time per turn, and, through the use of computer displays, kept informed of the elapsed time during each discussion period and each speaking turn.
- (f) During group discussions, the primary data that the computer files sequentially is information on when, and by whom, request buttons and talk buttons are pressed or released, along with information on when requests to speak are granted.
- (g) Instructions, information, and rating scales related to the experimental tasks are presented on each participant's screen. Each person first works alone and makes some individual

judgments about the team tasks, and after group discussion, a common team solution has to be proposed.

- (h) The quality of the final solution generated by the team is assessed by comparing it to expert judgments; this constituted the major outcome measure of the effectiveness of team problem-solving efforts.
- (i) Aspects of the dynamics operating within each group are measured on self-report questionnaires following the consensus decision. In our later studies this was supplemented by ratings of interaction profiles (Bales, 1950) obtained from observations of taped discussions.

The use of teleconferencing

Studying communication in a computer-mediated setting provided an effective vehicle for investigating such variables as turn-taking rules and informational feedback. However, the social dynamics involved in teleconferencing are also of interest in their own right. Whenever two or more people are "wired together" so that they may communicate, a teleconference occurs. Pairs of individuals, small work teams, or larger committees may "come together" to discuss factual issues, resolve conflicts, or discuss problems of common concern. They may do so without leaving their home bases, thus saving travel time and maintaining access to local resources (libraries, files, assistants, etc.).

The use of teleconferencing is becoming increasingly common in our society. For example, AT&T is attempting to persuade business organizations to install private Picturephone rooms throughout the country, and its Picturephone Meeting Service was made available to the general public this year (Newsweek, 1982). It therefore becomes

important to learn how the use of such telecommunication systems affects team functioning and outcomes. While several dozen experiments have compared the effects of general classes of telecommunication media (e.g., audio-and-video systems, such as the Picturephone, versus audio-only systems--see Chapanis, 1975 for examples of this research), few have compared different systems of the same general type (Williams, 1977). In our own research, however, we have focussed on a particular audio-only system and varied specific details of its operation.

Dependent variables

Three types of data were obtained during each experimental session: participation, performance, and perceptions. Individual level of participation included how frequently and for how long each participant requested to talk and actually talked. Team performance was determined by a comparison of each team's decisions with those recommended by experts (which could be quantified as a single index of effective problem solutions). Finally, perceptions of role relationships, leadership, feelings of the worth of individual contributions, and other aspects of group process were recorded on the group dynamics questionnaire.

Independent variables

A number of different independent variables were introduced over the course of the five studies in our research program. They include: (a) turn-taking rule; (b) informational prompts; (c) shyness (or communication apprehension); (d) gender composition of the teams; and (e) assigned leadership role. In addition, one study compared the process and product measures obtained in face-to-face team interactions with those generated by the computerized teleconferencing situation. The variables examined in each experiment and the major findings observed are summarized next.

Summary of Research FindingsPilot Study

(Males, Shyness varied, EQTS rule, Logic Task)

Each 4-man team was homogeneous with respect to shyness (all very shy, all moderately shy, all moderately assertive, or all very assertive), as measured by the McCrosky (1970) communication apprehension scale. The teams worked on logic tasks. Decisions were evaluated according to how well available information was utilized. Only the EQTS rule was used to select speakers during the group discussions.

Key Findings:

1. On the first problem-solving task the total amount of time spent requesting a talking turn was directly and negatively related to shyness level.
2. The EQTS rule exerted a significant effect on those who were moderately shy. Over time, they substantially increased their requests to talk until they were doing so more than even the most assertive participants.
3. Those who were most motivated to request talk turns, as shown by a willingness to hold their request buttons down while others talked and during pauses, ended up talking the most. The moderately shy members talked slightly more than the most assertive ones, followed by the moderately assertive, and last and least were the very shy. The EQTS rule had no effect on the low level of responding among this inhibited group of people.
4. Teams of assertive participants made better decisions than those composed of only shy individuals. Surprisingly, the poorest performance was found in the moderately shy group. This may be due to a paradoxical

effect of the EQTS rule. On the one hand, it enhanced motivation to talk in a situation where one could get the floor by simply pressing a button and then could talk for an uninterrupted time. On the other hand, when all members of a team become more motivated to talk, there are more ungranted requests to speak. Frustration and other reactions interfere with the information-processing activities required to solve the complex logic tasks used in this study.

Study 2

(Females, Shyness varied, EQTS and FIFO rules,
Informational Prompts varied, Survival Tasks)

Each team of 2 shy and 2 not-shy women worked on two survival tasks (desert and subarctic) (see Eady & Lafferty, 1975; Lafferty & Weber, 1978). Each team worked under both the EQTS and the FIFO rules; rule, order and survival setting were counter balanced. In addition, half of the teams received informational prompts in both survival situations, while the others were randomly assigned to a no-prompts condition. The prompts were continually updated displays of the percentage of time each member had spoken thus far.

Key Findings

1. The highest quality of team effectiveness was found in teams that performed under computer-mediated conditions of EQTS with prompts.
2. Differences due to turn-taking rules were less than predicted, in part because the EQTS rule was not activated very often to resolve conflicts among simultaneous requests to talk.
3. Prompts proved to have a range of effects on participation and perception measures. The shys talked more, while the not-shys talked less

when they got objective feedback on the extent of each member's participation. The usual dominance of not-shys over shys was reduced, as reflected in both request time and talk time. Prompts made shys feel more influential and not-shys feel less so. Although prompts made shys feel more frustrated and report greater tension (due perhaps to public exposure of their reticence), nevertheless they enjoyed the EQTS condition with prompts more than any other.

4. Not-shys were more likely to be perceived by others and by themselves as leaders--but only in the FIFO condition, and not under EQTS.

5. Shys were more likely than not-shys to perceive their main contribution to the team as the passive one of "listening." However, prompts eliminated this difference by leading shys to perceive themselves as more active participators.

Study 3

(Male, Female, and Mixed-sex Teams, Shyness varied,

EQTS rule, Prompts varied, Survival Task)

Each team consisted of 2 shy and 2 not-shy members who discussed either the desert or subarctic survival task under the EQTS rule. Ten teams were composed of all males, ten were all female, and ten were mixed-sex teams (two men and two women). Within each gender type, half of the teams received informational prompts, and the others did not. The laboratory conditions were changed to increase the physical isolation of each team member from the others by having each one function in a separate, individual cubicle.

Key Findings

1. In mixed-sex teams males talked more than females.
2. Mixed-sex teams rarely named females as leaders.

3. Both within-team and between-team comparisons indicated that females were LESS likely to see their main contribution as an active, task-relevant one and MORE likely to see listening as the most important thing they did.
4. Observer ratings showed females in mixed-sex teams to be less verbally assertive than their male teammates.
5. Again, prompts affected a number of individual and group processes. In the all female groups, prompts increased talking by the shy, and decreased talking by the not-shy. In the male groups and mixed-sex groups, however, prompts exerted a suppressing effect on talking among the shy.
6. Prompts affected feelings of influence. In all-female teams, they made shys feel more influential and not-shys feel less influential. In mixed-sex teams, the opposite effect occurred. Also, in these teams, prompts made females feel less influential than males. In all-male teams, prompts made shys feel less influential and had no effect on not-shys.
7. Prompts changed the perceptions of team members, making them more likely to perceive the shys as leaders.
8. Within mixed-sex teams, females felt less tension than males without prompts, but more tension when prompts were present.
9. Prompts increased the average length of requests among all subjects, significantly so for the shys.
10. None of the independent variables were found to influence quality of group decisions.

Study 4

(Mixed-sex, Shyness varied, EQTS-no prompts, Telecommunication vs.
Face-to-Face Setting)

Ten mixed-sex teams were tested, half of them under the EQTS-no prompts version of the telecommunication system employed in the previous studies and half in a more natural face-to-face team setting. Within each team one male member and one female were shy; the other male and female were not-shy. In the face-to-face condition, members did not press a response button prior to talking; their talking turns were recorded by observers who tracked the sequence and duration of talking of each team member from videotapes of each session. Content analyses were made of tape recordings of the telecommunication groups and the face-to-face groups using a modified version of Bales' Interaction Process Analysis.

Key Findings

1. The sex difference favoring male domination of total talking time that we found earlier was replicated. In both telecommunication and face-to-face settings, males did about 60 percent of the talking and females about 40 percent. Thus, the sex difference in extent of participation in our earlier study cannot be attributed to the features of the telecommunication system (which would seem to be more stereotypically masculine in its formality, rigid structure, and emphasis on high technology). But it must be noted that these female participants come from a population of extremely gifted students, many of whom take computer courses and have worked in team settings. On the other hand, their deference to male members (or the social control assumed by the males) becomes all the more striking when we consider the intellectual equality of these males and females.

2. The communication setting did have an impact on the quality of the team interaction. The telecommunication setting generated more assertive statements and more expressions of positive feelings than did the face-to-face one. Curiously, women's statements were more consistent with a feminine schema in the telecommunication setting—they were much less assertive and expressed fewer negative feelings than did the men. In the natural setting, however, women made more assertive statements than men, tried more often than men to structure the decision process, and showed a higher ratio of negative to positive expressions of feelings.
3. Their more active role when face-to-face with other team members led women to feel more involved in the team's efforts and to see themselves as playing a more active role than in the telecommunication setting.
4. Contrary to a common sense prediction, observer ratings revealed that subjects seemed less comfortable in the face-to-face than the telecommunication settings.
5. Though females were more involved and active in the face-to-face setting, it made them feel more frustrated than they did in the telecommunication setting—but males felt less frustrated when face-to-face.
6. Across both settings, only males were perceived as the team leaders.
7. As expected, shys of both sexes offered task solutions in a less assertive manner than did not-shys, and they expressed fewer emotions, either positive or negative—findings that held across task settings.
8. Teams working in the telecommunication setting made better decisions (their rankings of the value of survival items were closer to expert rankings). In addition, members perceived their teams' decisions to be better in the telecommunication setting.

Study 5

(Mixed-sex, Shyness varied, Face-to-face,

Leadership role assigned to a female or unassigned)

Ten mixed-sex teams worked on a survival task, all in a face-to-face setting. In each group one member of each sex was shy and the other not-shy. In five of the teams a leadership role was randomly assigned to one of the women, while no team member was designated leader in the other teams. The leader had an attributed status as "pilot." (The other three team members were designated as "passengers.") In addition, she was told which survival strategy was best and why.

Key Findings

1. Assigning a leadership role to a woman in a mixed-sex team had profound effects across all three of our general measures of participation, performance and perception.
2. In this condition, the verbal dominance of males was overcome. Women increased their participation, while men's talking times decreased, resulting in greater verbal output among the women.
3. The women designated as pilot usually talked the most, more than the other women and often more than even the not-shy men. There was a complete reversal of male-female proportion of talking time from 56.44 in the no-leader teams to 37:63 in female-pilot teams.
4. In the female-pilot condition the strategy decisions were better than in any other condition in our research program.
5. Women were more likely to be perceived as leaders in the female-pilot condition, although the woman-pilot herself did not acknowledge that she was the task leader.

6. The level of tension was reported as less in the female-pilot condition than the no-leader condition—among both males and females. It should be added, however, that men tended to enjoy this condition less.

The above five integrated studies are reported in two Technical Reports: studies 1-3 in ONR Technical Report Z-82-01, and studies 4-5 in Z-82-02. Two earlier technical reports were also completed under the tenure of this contract. An abstract of each is presented below.

Technical Report Z-79-01. On resisting social influence. Andersen, S., & Zimbardo, P.

Resisting social influences becomes important when such influences can be appropriately thought of as "mind control." When information is systematically hidden, withheld or distorted it is impossible to make unbiased decisions. Under these circumstances, people may be subtly led to believe they are "freely" choosing to act. It is precisely this kind of decision that persists and most affects our behavior since we come to believe in those attitudes and actions for which we have generated our own justifications. The thesis of this essay is that "mind control" exists not in exotic gimmicks, but rather in the most mundane aspects of experience. Because it does, it is possible to reduce our susceptibility to unwanted coercive control by increasing our vigilance and by learning how to utilize particular basic strategies of analysis. We present a series of troublesome situations followed by strategies of resistance which are broadly applicable to the wide array of mind-manipulation attempts that surround us daily.. Our sources have included surveys of relevant social-psychological research, as well as interviews and personal experiences with con men, cultists, super-salesmen and other perpetrators of mind control. Pragmatic advice is blended with a conceptual analysis of the basic issues on which vulnerability to persuasion rests—in the hope that individuals who find

they must make decisions on the basis of contrived communications will be better able to transform them into thoughtful, meaningful choices.

Technical Report Z-79-02. Modifying shyness-related social behavior through symptom misattribution. Brodt, S.E., & Zimbardo P. G. This also appeared in Journal of Personality and Social Psychology, 1981, 41, 437-449.

An experimental misattribution paradigm proved to be a powerful intervention treatment for altering social participation among dispositionally shy women. When the arousal symptoms they usually associated with social anxiety were misattributed to a non-psychological source, high frequency noise, these extremely shy women behaved as if they were not shy. Their verbal fluency and interactional assertiveness resembled that of not-shy comparison women, while differing significantly from shy cohorts. In addition, their physiological arousal, measured as change in heart rate over the course of the interaction, declined. The general modification of their demeanor was also reflected in a stronger tendency to prefer social affiliation than was shown by those in the shy and not-shy comparison groups. Finally, the majority were misjudged by their male partner as not being shy. Of further interest is the placebo effect discovered among the not-shy women also given this same misattribution manipulation: they become physiologically aroused, interpreted it as negative affect, and did not prefer to affiliate with their partner. The conceptual and pragmatic implications of this cognitive intervention strategy are discussed.

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